REMARKS

I. INTRODUCTION

The Office Action mailed on August 6, 2007 and the references cited therein have been carefully studied and, in view of the following remarks, reconsideration and allowance of this application are most respectfully requested. Claims 1-34 are currently pending in the present application, and claims 1-34 have been rejected.

II. REJECTIONS UNDER 35 U.S.C. § 112, SECOND PARAGRAPH

Claims 1, 6, 9, 17, 20-21, 24, 31-34 stand rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. The Examiner states that certain claims terms render these claims indefinite, including "bulk heterojunction," "small molecule," "surface area-to-volume ratio," "diameter," and "the cohesive energy of the first organic small molecule is such that the first small molecule material tends to adhere to itself rather than the underlying substrate." Applicants respectfully disagree with the Examiner's positions and submits that the claim terms are in full compliance with 35 U.S.C. § 112, second paragraph, for the reasons set forth in detail below.

The essential inquiry pertaining to the definiteness requirement of 35 U.S.C. § 112, second paragraph, is whether the claims set out and circumscribe a particular subject matter with a *reasonable* degree of clarity and particularity. Definiteness of claim language must be analyzed, not in a vacuum, but in light of: (a) the content of the particular application disclosure; (b) the teachings of the prior art; and (c) the claim interpretation that would be given by one possessing the ordinary level of skill in the pertinent art at the time the invention was made. MPEP 2173.02. In reviewing a claim for compliance with 35 U.S.C. 112, second paragraph, "the examiner must consider the claim as a whole" and "the totality

of all the limitations of the claim and their interaction with each other must be considered to ascertain the inventor's contribution to the art." MPEP 2173.02. Further, the test for indefiniteness is whether the a person skilled in the art would understand what is claimed when the claim is read in light of the specification, not whether more suitable language or modes of expression are available. *Id.*

bulk heterojunction

The Examiner has rejected claims 1, 17 and 33-34 under 35 U.S.C. 112, second paragraph, as being indefinite due to the term "bulk heterojunction." In explanation, the Examiner states that "the term 'bulk heterojunction' as defined in the specification fails to define the degree to which interpenetration of the two phases occurs." *See* Page 2, ¶ 2 of Office Action mailed on August 6, 2007. The Examiner then reaches the conclusion that "therefore, any amount of interpenetration between the two phases, even at an atomic scale, meets the term "bulk heterojunction." *See* Page 3, ¶ 2 of Office Action mailed on August 6, 2007. Applicants respectfully disagree.

The term "bulk heterojunction" is a term of art that has been used do describe the highly convoluted interface achieved in some polymer-based photovoltaic cells. In contrast to standard planar heterojunctions, "bulk heterojunctions seek to create a highly interfolded or interpercolating network of the donor and acceptor materials." Paragraph [0010]. Figure 1 clearly demonstrates the difference between a bilayer cell having a planar heterojunction (Fig, 1a) and a bulk heterojunction (Fig. 1b). Also, the specification explains that "in a bulk heterojunction, the DA interface is highly folded such that photogenerated excitons are likely to find a DA interface within a distance L_D of their generation site." Paragraph [0029].

small molecule

The Examiner has rejected claims 1, 6, 9, 17, 20-21, and 31-34 under 35 U.S.C. 112, second paragraph, as being indefinite due to the term "small molecule." In explanation, the Examiner states that "the term 'small molecule' is a relative term that renders the claim indefinite." *See* Page 3, ¶ 3 of Office Action mailed on August 6, 2007. The Examiner then reaches the conclusion that "therefore, any molecule can be considered a small molecule." *Id.* Applicants respectfully disagree.

In the context of the specification and the claims, and as would be readily appreciated by a person skilled in the art, the term "small molecule" refers to a material that is not a polymer and that can be deposited by vapor-phase deposition (due to a sufficiently high vapor pressure). *See* paragraph [0004]. A person skilled in the art would readily would understand the term "small molecule" when the claim is read in light of the claims as a whole and the specification.

surface area-to-volume ratio

The Examiner has rejected claims 1, 17, and 33-34 under 35 U.S.C. 112, second paragraph, as being indefinite due to the term "surface area-to-volume ratio." In explanation, the Examiner states that "the term 'surface area-to-volume ratio' is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention." *See* Page 3, ¶ 4 of Office Action mailed on August 6, 2007. The Examiner further states that "the specification does not define what constitutes the 'volume' portion of the term" and "therefore, it is unclear as to what volume of the first layer is included in determining the 'surface area-to-volume ratio,' such as the entire amount of space in three dimensions of the

entire first layer or the portion of the amount of space in three dimensions of the first layer which is interpenetrated." *Id.* Applicants respectfully disagree.

Applicants note that none of the recited claims (1, 17, and 33-34) contain the term "surface area-to-volume ratio." However, the term is recited in claims 4 and 5. Claim 4 recites "the first layer has a surface area-to-volume ratio of at least 2:1, wherein the surface area and volume are measured in micrometers." Claim 5 is analogous but recites a ratio of at least 5:1. Applicants respectfully submit that claims 4 and 5 are perfectly clear. As is readily understood from the language of the claim, the term "volume" as recited in claims 4 an 5 has its customary meaning and refers to the volume of the first layer. As noted by the Examiner, "surface area" is defined in the specification as the area of the first layer that is in contact with the second layer (as opposed to the surface area of the remaining sides and bottom of the first layer). Thus, as would be recognized by a person skilled in the art, the surface to volume ratio for the first layer is simply the ratio of the surface of the first layer that contacts the second layer to the area of the first layer.

In contrast to the Examiner's assertion that "the term 'surface area-to-volume ratio' is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention," claims 4 and 5 recite ratios of 2:1 and 5:1, respectively. Thus, the "standard for ascertaining the requisite degree" is set forth in claims 4 and 5, and a person skilled in the art would be fully apprised of the scope of the invention.

the cohesive energy of the first organic small molecule is such that the first small molecule material tends to adhere to itself rather than the underlying substrate

The Examiner has rejected claims 9 and 24 under 35 U.S.C. 112, second paragraph, as being indefinite due to the term "the cohesive energy of the first organic small molecule is

such that the first small molecule material tends to adhere to itself rather than the underlying substrate." In explanation, the Examiner states that the claim does not define "the degree to which the adherence occurs" and that "the claim merely states that the material only 'tends' to adhere to itself and does not actually require a degree for this tendency to actually occur." *See* Page 4, ¶ 5 of Office Action mailed on August 6, 2007. Applicants respectfully disagree. The claims, *when read as whole*, do provide a degree to which the self-adherence occurs. The claim element compares the self-adhesion of the first organic small molecule to the adhesion of the first organic small molecule to the substrate and require the self adhesion occur to a greater extent. Thus, applicants respectfully submit a person skilled in the art would be fully apprised of the scope of the invention.

diameter

The Examiner has rejected claims 20 and 21 under 35 U.S.C. 112, second paragraph, as being indefinite due to the term "the diameter of the protrusions." In explanation, the Examiner states that the claim "does not define what constitutes 'the diameter' and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention." *See* Page 5, ¶ 6 of Office Action mailed on August 6, 2007. Applicants respectfully disagree. The term diameter is clear on its face and would be readily understood by a person skilled in the art. Diameter is commonly defined as "the width of a circular or cylindrical object." Random House Webster's College Dictionary, Random House, New York (1999), p. 365.

For the reasons set forth above, Applicants respectfully submit that the claims are in full compliance with the requirements of U.S.C. 112, second paragraph.

III. REJECTIONS UNDER 35 U.S.C. § 102

Claims 1-3, 9-11, 17-19, 24-26, and 33-34 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Ishikawa (Appl. Phys. Letts.), Han ('665), Saurer ('570), and Foust ('508).

For each reference, the Examiner assumes that any conventional interface would constitute a "bulk heterojunction." The Examiner states that "any two layers meet the claim since all layers have at least some protrusions or interpenetration, even if it occurs at the atomic scale. Applicants respectfully submit that the term "bulk heterojunction," as defined in the specification and as would be understood by a person skilled in the art, is readily distinguished from the conventional bilayer heterojunctions disclosed in the prior art cited by the Examiner. None of the references cited by the Examiner teach or suggest the presently recited bulk heterojunction.

Bulk heterojunction devices, as understood by one skilled in the art, are characterized by an interpenetrating network of donor and acceptor materials, providing a large interface surface area where photoinduced charge transfer by excitons into separated electrons and holes can efficiently occur. The interface in a bulk heterojunction taught by Applicants may be characterized as being "highly folded" such that it has a relatively high surface area-to-volume ratio. The protrusions described by Applicants, i.e. the protrusions of the first organic layer, are the results of deliberate design to increase the surface area-to-volume ratio. *See* specification paragraphs [0041]-[0042]. It is believed that "[b]y increasing this surface area-to-volume ratio, the exciton dissociation probability, and hence the efficiency, of the fabricated optoelectronic device are increased." *See* specification paragraphs [0029] and [0038].

Applicants believe that organic small-molecule bulk heterojunctions had not been successfully fabricated using OVPD prior to this invention. Polymer bulk heterojunctions had previously been fabricated by spin coating (*see* specification paragraphs [0027] and [0029]) and small molecule bulk heterojunctions had been fabricated by co-

deposition and annealing with physical confinement to create phase separation. However, as explained in paragraphs [0030]-[0031] of the present specification, bulk heterojunctions in organic small molecular systems had been largely unsuccessful.

A. Ishikawa (Appl. Phys. Letts.)

Claims 1-3, 9-10, 17-19, 24-25, 29 and 33-34 stand rejected under 35 U.S.C. § 102(a) as being anticipated by Ishikawa et al., Appl. Phys. Letts. 2004, 84 (13), 2424-2426 ("Ishikawa"). Applicants respectfully submit that Ishikawa does not anticipate the claims for at least the following reasons.

The Examiner states that "Ishitawa teaches a method of producing an optoelectronic device . . . by an organic vapor deposition method." Applicants respectfully submit that this is incorrect. Ishikawa does not teach or suggest the use of organic vapor phase deposition (OVPD). Rather, Ishikawa uses evaporative spray deposition from ultradilute solution (ESDUS). The ESDUS is used for the spray deposition of polymers such as the MEV-PVP used in Ishikawa. In contrast, the OVPD recited in the claims is a method of depositing small organic molecules rather than polymers. In order to use OVPD, an organic material needs to have a sufficiently high vapor pressure to be evaporated from the solid phase. This is a property of small molecules according to the present invention.

Also, Ishikawa is distinguished from the presently claimed invention as Ishikawa does teach or disclose the steps of depositing a first layer and depositing a second layer in physical contact with the first layer. Rather, the devices of Ishikawa are prepared by co-deposition of the two materials PCBM and MEH-PPV from a dilute solution which contains both materials. Ishikawa does not teach or suggest the sequential deposition of the two layers as is required by the claims.

For at least the foregoing reasons, Applicants respectfully submit that the claims are not anticipated by Ishikawa and therefore request that the rejection be withdrawn.

B. Han ('665)

Claims 1-3, 9-11, 17-19, 24-26, and 33-34 stand rejected under 35 U.S.C. § 102(b) as being anticipated by United States Application Pub. No. 2001/0032665 ("Han"). It is respectfully submitted that these rejections should be withdrawn for at least the following reasons.

To anticipate a claim, the reference must disclose each and every element of the claimed invention. *Verdergaal Bros. v. Union Oil Co. of Cal.*, 814 F.2d 628, 2 USPQ2d 1051 (Fed. Cir. 1987). Applicants respectfully submit that Han does not disclose or suggest each and every element of these claims. Drawings and pictures can only anticipate claims if they clearly show the structure which is claimed. *In re Mraz*, 455 F.2d 1069, 173 USPQ 25 (CCPA 1972). The picture must show all the claimed structural features and how they are put together. *Jockmus v. Leviton*, 28 F.2d 812 (2d Cir. 1928). When the reference does not disclose that the drawings are to scale and is silent as to dimensions, arguments based on measurement of the drawing features are of little value. See *Hockerson-Halberstadt, Inc. v. Avia Group Int'l*, 222 F.3d 951, 956, 55 USPQ2d 1487, 1491 (Fed. Cir. 2000) (The disclosure gave no indication that the drawings were drawn to scale. "[I]t is well established that patent drawings do not define the precise proportions of the elements and may not be relied on to show particular sizes if the specification is completely silent on the issue.").

Applicants submit that Han does not disclose or suggest a bulk heterojunction as claimed by Applicants. The Examiner believes that the Figure 1 of Han shows a bulk heterojunction "since it has some protrusions (as shown in, for example, Fig. 1)." *See* Page 7, ¶ 9.a of Office Action mailed on August 6, 2007. Applicants respectfully submit that the Examiner has mischaracterized the device depicted in Fig. 1 of Han and appears to misunderstand the term "bulk heterojunction."

Han does not teach or suggest a bulk heterojunction. Although Fig. 1 of Han depicts wavy lines, Applicants respectfully submit that this does not teach a bulk heterojunction as claimed by Applicants. There is no discussion in Han what the dark wavy

line (labeled 4) indicates, or how and from what it is formed. There is no teaching or suggestion in Han that would indicate that the interfaces, although possibly depicted by a wavy line, are anything but conventional. Nowhere in Han is the term "bulk heterojunction" mentioned, nor is there any teaching or suggestion of a bulk heterojunction or how it would be formed.

Thus, for at least the preceding reasons, Applicants respectfully submit that Han does not anticipate claims 1-3, 9-11, 17-19, 24-26, and 33-34 in this application.

C. Saurer ('570)

Claims 1-5, 9-11, 17-21, 24-26, and 33-34 stand rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent 5,482,570 to Saurer et al. ("Saurer"). It is respectfully submitted that these rejections should be withdrawn as Saurer does not disclose or suggest each and every element of these claims.

Applicants respectfully submit that Sauer does not teach or suggest the presently claimed methods at least because Sauer does not teach bulk heterojunctions as understood by one skilled in the art and as defined in this application by Applicants. As taught in the present specification, and as would be understood be a person skilled in the art, a bulk heterojunction is characterized by an interpenetrating network of donor and acceptor materials, providing a large interface surface area where photoinduced charge transfer by excitons into separated electrons and holes can efficiently occur. The interface in a bulk heterojunction taught by Applicants may be characterized as being "highly folded" such that it has a relatively high surface area-to-volume ratio. Applicants respectfully submit that the "rough" surface of Sauer is not a bulk heterojunction.

D. Foust ('508)

Claims 1-5, 8-11, 17-19, 23-26, and 33-34 stand rejected under 35 U.S.C. § 102(e) as being anticipated by United States Application Pub. No. 2004/0121508 ("Foust").

It is respectfully submitted that these rejections should be withdrawn as Foust does not disclose or suggest each and every element of these claims.

Foust is directed to large organic devices and methods of fabricating such devices. The devices and methods taught by Foust use a flexible and rigid plastic substrate. However, Foust does not teach or disclose a bulk heterojunction.

The Examiner appears to believe that Foust teaches the method claimed in Applicants' independent claims 1 and 17. Specifically, the Examiner states that "[o]rganic compounds and other layers have some roughness wherein a first layer tends to adhere to itself, even at the atomic scale, *inherently forming protrusions since Foust teaches the method as disclosed in the claims 1 and 17.*" *See* Page 10, ¶ 11.a of Office Action mailed on August 6, 2007 (emphasis added). Applicants respectfully submit that Foust teaches no such method because Foust does not teach bulk heterojunctions as understood by one skilled in the art and as defined in this application by Applicants. Applicants submit that, for the reasons stated above, these alleged "protrusions" or "roughness" do not teach the bulk heterojunction disclosed and claimed by Applicants herein. Rather, Foust merely discloses conventional planar interfaces.

IV. REJECTIONS UNDER 35 U.S.C. § 103

Claims 4 and 5 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Han. It is respectfully submitted that these rejections should be withdrawn for at least the following reasons.

Applicants respectfully submit that the Examiner has misinterpreted Han as teaching a first layer having a surface area to volume ratio of at least 5:1. *See* ¶ 13 of Office Action mailed on August 6, 2007. The Examiner cites paragraph 0036 of Han as teaching a first layer having a thickness of 0.01 microns. The Examiner states

> However, one would be motivated to set the *top and bottom surface area* as large as possible, such as on the order of meters, in order to produce a large area for incident light. Therefore, it would have been obvious to one or ordinary skill in the art at the time the invention was made to set the

> surface area to volume to be greater than 5:1 in microns since in order to produce economic quantities of current the area for incident light of a photoelectric conversion device on any size that is beyond the scale of microns.

See ¶ 13 of Office Action mailed on January 8, 2007

The Examiner's comment, to the extent they can be understood, only relate to increasing surface area, but does not address volume or the ratio of surface area to volume. Also, Applicants respectfully point out that in [0038] of the specification, Applicants specifically state that the "surface area" does not refer to the area of the top and bottom of the layer as is suggested by the Examiner, but only to the *surface area of the deposited first layer which will be in contact with the second layer* (i.e. the interface of the first and second layers).

Claims 20 and 21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Saurer. It is respectfully submitted that these rejections should be withdrawn for at least the following reasons.

The Examiner states that "Saurer teaches that a 'diameter' of the protrusions are preferably less than the exciton diffusion layer of the first small organic molecule, which would be less than 1 times the exciton diffusion length (Col. 5, Lines 22-29)." *See* ¶ 14 of Office Action mailed on January 8, 2007. Applicants respectfully submit that this statement is incorrect. Saurer does refer to the exciton diffusion length of the material, but rather refers to the "diffusion length of the minority carriers." Saurer, Col. 5, lines 22-23. The minority carriers refer to holes and electrons, not to excitons. Saurer, Col. 5, lines 20-22. Saurer does not teach or suggest the claimed protrusions or that the protrusions have a diameter of 1 to 5 times the exciton diffusion length of the first organic small molecule material.

Claims 12-13, 22, 27-28 and 31-32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Sauer in view of Forrest ('846). Claims 14-16 and 29-30 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Sauer in view of Forrest ('846) and in view of Foust. Claims 6-8 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Foust in view of Forrest ('102). Claims 12-16, 22 and 27-32 are rejected under 35

U.S.C. § 103(a) as being unpatentable over Foust in view of Forrest ('846). Claims 20 and 21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Foust in view of Forrest ('462). Claim 7 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Saurer in view of Forrest ('102) and further in view of Forrest ('846). Claim 8 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Saurer in view of Forrest ('102) and further in view of Yoshino (IEEE). Claim 23 is rejected under 35 U.S.C. § 103(a) as being unpatentable over Saurer in view of Yoshino (IEEE). Applicants respectfully submit that each of these rejections should be withdrawn for at least the following reasons.

As discussed in detail above, Saurer and Foust do not teach or suggest each limitation of any of the pending claims. These deficiencies are not over come by any of the secondary references-- Forrest ('846), Forrest ('102), Forrest ('462), and Yoshino (IEEE) -- cited by the Examiner as none of these references teach or suggest the claimed bulk heterojunction.

Thus, Applicants respectfully submit that the rejections under 35 U.S.C. § 103 have been overcome and should therefore be withdrawn.

V. CONCLUSION

Applicants respectfully submit that the pending claims are now in condition for allowance and request that such action be taken. If for any reason the Examiner believes that prosecution of this application would be advanced by contact with the Applicants' attorney, the Examiner is invited to contact the undersigned at the telephone number given below.

Respectfully submitted,
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Dated: December 6, 2007 By: _____

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